VACCINE COVERAGE IN CANADIAN CHILDREN

RESULTS FROM THE 2015 CHILDHOOD NATIONAL IMMUNIZATION COVERAGE SURVEY (cNICS)

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SUMMARY

This report describes the 2015 childhood National Immunization Coverage Survey (cNICS) and its findings. Parents were asked to report vaccines received by their child based on their vaccination card or booklet, and asked about their own knowledge, attitudes and beliefs (KAB) regarding vaccines.

All of the coverage estimates were below the corresponding national vaccination coverage goals. Among two-year-old children, 89% had received at least one dose of measles, mumps and rubella vaccine and 77% had received the recommended four doses of diphtheria, tetanus and pertussis vaccine. Coverage estimates were lower in older age groups. It is important to note that the cNICS data collection method is more likely to under-report than to over-report vaccine doses received by children and therefore likely to under-estimate vaccine coverage in all age groups.

The large majority of parents (97%) agreed that childhood vaccines are safe and effective. Compared to previous surveys, fewer parents reported being concerned about potential side effects of vaccines, as this percentage dropped from 74% to 66% between 2011 and 2015. A small number of parents (15%) believed that practices such as chiropractic and naturopathy can replace vaccines, a drop from 20% in 2011.

In conclusion, vaccine coverage of Canadian children could be improved to achieve the national vaccination coverage goals for children and adolescents.

Ways to improve our data collection methods and additional data elements will be implemented in cNICS 2017 to minimize under-reporting and to gain a better understanding of factors associated with un- and under-vaccination status and systemic barriers to vaccination.

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BACKGROUND

The Public Health Agency of Canada (PHAC) routinely monitors vaccination coverage in Canada through the National Immunization Coverage Survey (NICS). Since 1994, the childhood National Immunization Coverage Survey (cNICS) has been conducted approximately every two years to estimate national uptake for all routine childhood vaccines that are recommended by the National Advisory Committee on Immunization (NACI) (1) and are part of publicly funded vaccination programs. The survey also includes questions on parental knowledge, attitudes and beliefs (KAB) to better understand the factors influencing decisions on immunization for their children. Since 2011, cNICS has been conducted by Statistics Canada on behalf of PHAC.

NATIONAL VACCINATION COVERAGE GOALS BY 2025

As part of the National Immunization Strategy objectives for 2016–2021, National vaccination coverage goals (2) were developed in 2017 for childhood and adolescent vaccines that are publicly funded in all provinces and territories. The goals and targets are consistent with Canada's commitment to World Health Organization (WHO) disease elimination targets and Global Vaccine Action Plan, while reflecting the Canadian context. These include a vaccination goal of 95% coverage for childhood vaccines (assessed at age 2 and 7) and 90% coverage for adolescent vaccines (assessed at age 17).

PHAC uses cNICS data to report Canada's progress toward achieving the National vaccine coverage goals and to meet its international vaccination coverage reporting obligations to the WHO and the Pan American Health Organization (PAHO). Results from the KAB section inform PHAC's work as well as that of other partner organizations involved in the promotion of vaccination.

METHODS

Statistics Canada conducted the 2015 cNICS between September 2015 and March 2016. The questionnaire was developed by Statistics Canada and PHAC in consultation with immunization program planners from across Canada. It was also reviewed by Statistics Canada's Questionnaire Review Committees before being used in the study.

The childhood vaccines included in the cNICS were those that are publicly-funded under provincial/territorial programs and appropriate for the selected age groups. Travel vaccines and vaccines for high-risk medical conditions were excluded. Human papillomavirus (HPV) vaccine coverage was measured only in girls because most boys in the study were not yet eligible for the vaccine at the time the survey was conducted. Although some HPV programs for boys started in 2012, the vaccine only became available as part of public programs for boys in all provinces and territories (PT) in the fall 2017.

SAMPLING

The target population consisted of all Canadian children excluding First Nations children living in reserve communities. The sampling frame was built using the Canadian Child Tax Benefit (CCTB) file, which includes all applicants to the CCTB. This roster is a representative sampling frame because it includes 96% of children across Canada (3). Households with children who were two, seven or 17 years of age and girls between 13 and 14 years of age as of March 1, 2015, were included in the study. Children were randomly selected from the sampling frame by Statistics Canada. The sampling method ensured that only one eligible child from each household was selected. Sampling was stratified by provinces and territories and by age group.

DATA COLLECTION FROM PARENTS OR GUARDIANS

Survey data was collected through a telephone interview with selected children's parent or guardian (hereafter referred to as the respondent) and a review of the child's healthcare record. The process is described below:

Mail-out notification:

Selected respondents were mailed a letter notifying them that Statistics Canada would be calling at a later date to collect vaccination information on a specific child in the household. Participants were asked to locate that child's vaccination card or booklet in advance of the telephone interview.

Telephone interview:

Using a telephone number (including landline or cell phone) provided in the CCTB file, a trained Statistics Canada interviewer contacted the respondent. The respondent was asked to retrieve the selected child's vaccination booklet or some other record of vaccinations, such as a school record for the interview.

If the respondent was able to locate their child's vaccination booklet at the time of the first call, respondents were asked:

1. To read the booklet and provide the names of the vaccines and dates administered;
2. To report any other vaccinations not listed in the booklet (e.g. a school record);
3. To recall by memory whether the child was ever vaccinated for: hepatitis B (17 year-olds only) and HPV (13–14 and 17 year-old girls only) if it was not already reported;
4. To answer a series of questions related to KAB regarding vaccination, such as their perception of vaccine safety, the importance of vaccines in preventing disease and where they look for information on vaccination;
5. To answer questions on the family/child demographics, such as education, income, and country of birth;
6. To give their permission for Statistics Canada to contact the child's healthcare provider(s) to supplement the vaccination information provided during the interview. All age groups in the study were included in this step.

If the respondent was not able to locate their child's vaccination booklet at the time of the call, they were only asked the questions that were based on memory recall, KAB questions and demographic questions, as described above.

To allow the respondent more time to locate the child's vaccination booklet, three follow-up telephone attempts were made to complete the questionnaire. If the respondent was successful in locating the booklet in a subsequent telephone attempt, they were asked to provide vaccination information from the booklet. If the booklet was still unavailable after three attempts, permission was asked to follow-up with the child's healthcare provider.

For 18.4% of respondents, only the KAB data and vaccinations based on memory recall were collected. These respondents were not able to locate their booklets and information was not received from their healthcare provider.

DATA COLLECTION FROM HEALTHCARE PROVIDERS

A consent form was mailed to all respondents who had agreed over the phone to have their healthcare provider(s) contacted. The consent form requested for the name and contact information of all healthcare providers (e.g. physician, public health unit, health clinic) that vaccinated their child.

While 88.5% of respondents verbally agreed to have Statistics Canada follow up with their healthcare provider, only 57% of them returned their completed consent form.

Statistics Canada followed up with all the healthcare providers identified in the consent forms and offered them a $25 stipend for their time needed to collect the data. Healthcare providers were asked to record all the vaccinations given to the child and the corresponding dates of when vaccine was administered. Healthcare provider responses were received for approximately 40% of the overall participants in the study.

DATA PROCESSING

For vaccination information which had responses from the telephone interview and from the healthcare provider, the two sources were combined to capture a more complete vaccination record.

In Canada and other countries, diphtheria, pertussis and tetanus antigens are given in a combination vaccine and are not available to children as a single-antigen vaccine. If two of the three antigens were reported in the child's immunization records at a given date, it was assumed that they received all three antigens on that day. This correction was not made for other combination vaccines because other antigens may have been administered as a single antigen vaccine in Canada and/or other countries (e.g. *Haemophilus influenzae* type B, measles).

Children were considered to be vaccinated for specific antigens if they had received the recommended number of doses by two, seven, fourteen and seventeen years of age. Variation in PT vaccination programs were considered in calculating the required number of doses. Minimum ages and minimum intervals were not considered when counting doses. However, two doses of the same antigen had to be at least 28 days apart to be considered as distinct.

DATA ANALYSIS

Analysis was completed using SAS 9.3 and SUDAAN 11.0.1. Based on parental and healthcare provider reports, coverage was calculated as the proportion of the eligible sample that was vaccinated. Coverage was weighted to be nationally representative of the Canadian population as of March 2015 and adjusted for non-response. Variances and weighted 95% confidence intervals were estimated using the bootstrap method. The quality level of an estimate is determined by the coefficient of variation. Estimates with a coefficient of variation from 16.6% to 33.3% indicated higher sampling error and are to be interpreted with caution. Estimates were considered unreliable if the coefficient of variation was greater than 33.3%; however, no estimates from cNICS 2015 exceeded that threshold.

RESULTS

PARTICIPATION AND RESPONSE RATES

The overall participation rates in cNICS 2015 were 50% for the coverage assessment and 54% for KAB (Table 1).

TABLE 1: Sampling and participation, by age group

AGE GROUP	2 YEARS		7 YEARS		13–14 YEARS (GIRLS ONLY)		17 YEARS		TOTAL	
	N	%	N	%	N	%	N	%	N	%
Children sampled from roster	707	–	733	–	806	–	893	–	3139	–
Children whose parents were contacted	529	74.8	543	74.1	641	79.5	688	77.0	2401	76.5
Children whose parents agreed to participate	498	70.4	514	70.1	602	74.7	629	70.4	2243	71.5
Children included in vaccination coverage assessment	376	53.2	307	41.9	431	53.5	454	50.8	1568	50.0
Children included in the KAB survey	378	53.5	391	53.3	449	55.7	463	51.8	1681	53.6

COVERAGE ESTIMATES FROM CNICS 2015

Children aged two years

The national vaccination goal of 95% was not met for any antigen in two-year-old children (Table 2). Although diphtheria, pertussis, tetanus, Hib and polio are always given together, reported coverage for four doses of Hib (72%) was much lower than those for four doses diphtheria, tetanus and pertussis (77%), which suggests an under-reporting. Coverage was higher for polio (91%), as children require only three doses of this antigen to be considered vaccinated.

Coverage estimates for measles, mumps and rubella were 89%. Coverage estimates were 88% for pneumococcal, 88% for meningococcal C, 75% for rotavirus and 69% for hepatitis B vaccines for two year old children.

TABLE 2: Estimated vaccination coverage of routine immunizations by two years of age

ANTIGEN	NUMBER OF DOSES	COVERAGE % (95% CI)
Diphtheria	≥ 4	76.9 (71.7–81.5)
Pertussis	≥ 4	77.0 (71.7–81.5)
Tetanus	≥ 4	76.7 (71.4–81.3)
Polio	≥ 3	91.2 (87.0–94.1)
Hib	≥ 4	71.9 (66.4–76.8)
Measles	≥ 1	89.2 (85.0–92.3)
Mumps	≥ 1	88.9 (84.6–92.1)
Rubella	≥ 1	88.9 (84.6–92.1)
Varicella	≥ 1	74.8 (69.3–79.7)
Pneumococcal	≥ 3–4	80.3 (75.1–84.7)
Meningococcal	≥ 1	87.8 (83.2–91.4)
Rotavirus	≥ 1	75.4 (69.2–80.6)
Hepatitis B*	≥ 3	69.2 (52.6–82.0)

* Only provinces and territories with an infant vaccination program are included in this coverage estimate.

Children aged seven years

The national vaccination coverage goal of 95% was not met for any antigen in seven-year-old children, although for rubella it came very close at 94% (Table 3). The difference in coverage estimates between rubella, measles and mumps is due to the number of doses required to be considered vaccinated. One dose of rubella is required by seven years of age compared to two doses of measles and mumps. Coverage for five doses of diphtheria, tetanus and pertussis antigens was estimated at 75%. Higher estimates for Hib (77%) and polio (90%) can be explained by the smaller number of doses required to be considered as immunized. The difference between polio and Hib estimates, based on the same number of doses, is difficult to explain and may be indicative of under-reporting for Hib.

TABLE 3: Estimated vaccination coverage of routine immunizations by seven years of age

ANTIGEN	NUMBER OF DOSES	COVERAGE % (95% CI)
Diphtheria	≥ 5	74.6 (69.1–79.4)
Pertussis	≥ 5	74.9 (69.4–79.7)
Tetanus	≥ 5	74.6 (69.1–79.4)
Polio	≥ 4	90.2 (85.9–93.3)
Hib	≥ 4	77.3 (72.2–81.7)
Measles	≥ 2	85.8 (81.2–89.4)
Mumps	≥ 2	86.2 (81.7–89.7)
Rubella	≥ 1	93.5 (89.9–95.9)

Girls aged 13–14 years

The uptake of at least one dose of HPV vaccine was estimated at 74.6% (95% CI 70.2–78.6). This estimate is used as a proxy measure for the vaccination coverage goal of 90% for HPV 2–3 doses depending on PT immunization programs.

Adolescents aged 17 years

The reported coverage for six doses of diphtheria, tetanus and pertussis was estimated at 60–62% (Table 4). This very low estimate can be explained by the fact that vaccines provided as part of school programs do not always get added to the parent-held vaccination records, such as the tetanus, diphtheria, and acellular pertussis booster (Tdap). This issue is discussed in more detail in the limitations section.

The proportion of adolescents having received at least one dose of hepatitis B vaccine was estimated at 88%. This estimate is used as a proxy for the vaccination goal of 90% for hepatitis B 2–3 doses based on PT immunization programs.

TABLE 4: Estimated vaccination coverage of routine immunizations in 17-year-old adolescents

ANTIGEN	NUMBER OF DOSES	COVERAGE % (95% CI)
Diphtheria	≥ 6	62.2 (56.2–67.8)
Pertussis	≥ 6	60.2 (54.2–65.9)
Tetanus	≥ 6	60.9 (54.9–66.6)
Polio	≥ 5	87.2 (82.2–90.9)
Hib	≥ 4	74.9 (69.3–79.8)
Measles	≥ 2	89.2 (84.7–92.5)
Mumps	≥ 2	87.7 (83.2–91.2)
Rubella	≥ 1	95.1 (91.8–97.1)
Hepatitis B	≥ 1	88.1 (84.4–90.9)

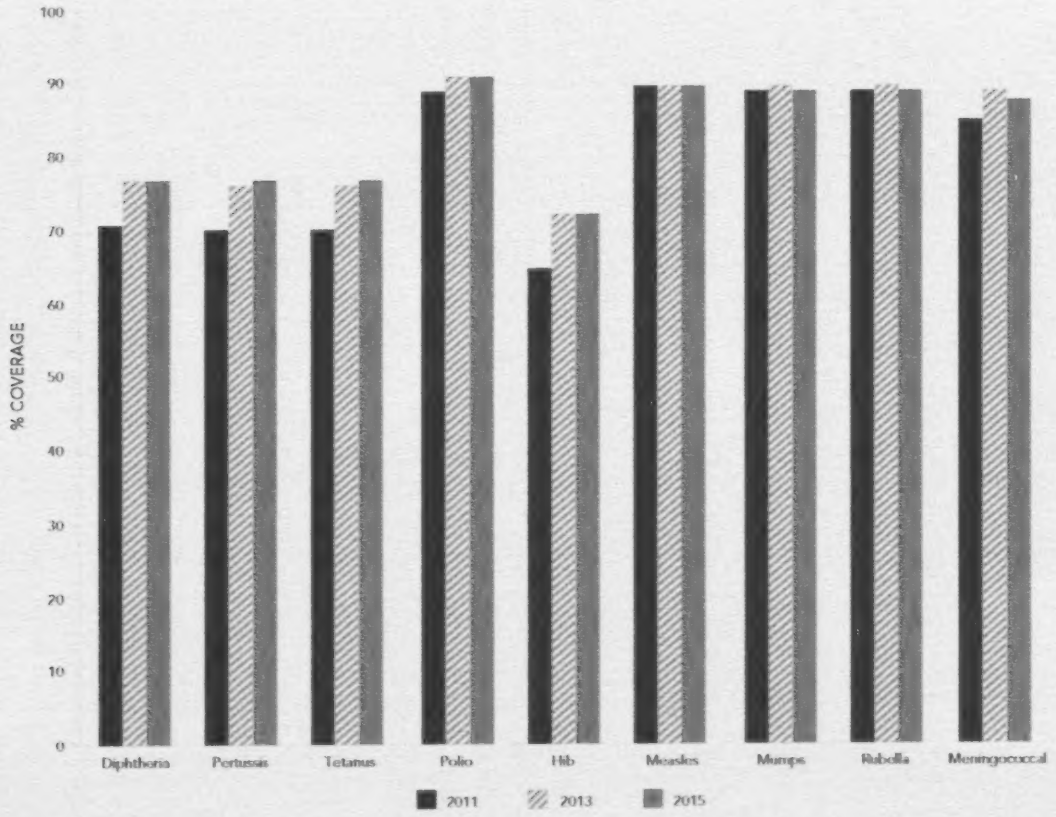
COMPARISON WITH PREVIOUS YEARS

The 2011, 2013 and 2015 iterations of cNICS used common design, data collection methods and variable definitions making results comparable, except for vaccines for which provincial/territorial programs changed over the years (hepatitis B, pneumococcal) and HPV in adolescents girls as the age group in which it was measured changed over years (10–14 years in 2011, 12–14 years in 2013 and 13–14 years in 2015).

In two-year-old children (Figure 1), vaccine coverage for diphtheria, pertussis, tetanus and Hib increased significantly between 2011 and 2013 and remained stable between 2013 and 2015.

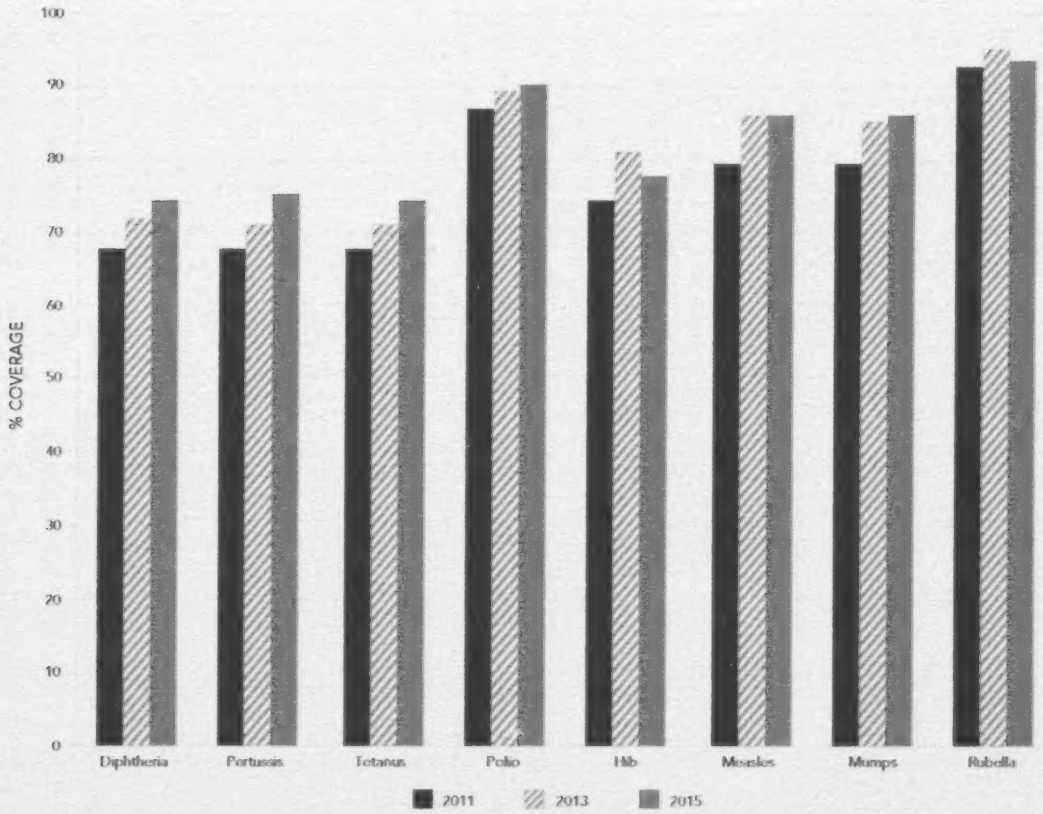
In seven-year-olds (Figure 2), coverage for Hib, measles and mumps increased significantly between 2011 and 2013. The discrepancy between Hib estimates is most likely unreliable due to under-reporting, as explained in section 3.2. The increase in measles and mumps coverage in seven-year-olds could be explained in part by an increase in awareness due to measles outbreaks in British Columbia in 2010 (4) and in Quebec in 2011 that received media attention (5). In addition, a large catch-up campaign was undertaken in Québec in response to the 2011 outbreak, which resulted in an increase by 7% of the proportion of children having received two doses of the measles, mumps and rubella (MMR) vaccine (5).

FIGURE 1: Comparison of coverage estimates for two-year-old children from cNICS 2011, 2013 and 2015



We did not compare hepatitis B and pneumococcal vaccine data because of changes over time in provincial/territorial programs.
Varicella data are not show because of data quality concerns (see limitations section).
Actual numbers and results of statistical tests are shown in Appendix.

FIGURE 2: Comparison of coverage estimates for seven-year-old children from cNICS 2011, 2013 and 2015



Actual numbers and results of statistical tests are shown in Appendix.

KNOWLEDGE, ATTITUDES AND BELIEFS

The analysis of KAB showed that, overall, Canadian parents perceive vaccines as safe, effective and important for their children's health (Table 5). However, two thirds of them are concerned about potential side effects of vaccines, and more than one third believe that a vaccine can cause the disease it is meant to prevent –which is not true for any vaccine currently licensed in Canada.

For all questions on perceptions of vaccines in general, the proportion of responses favourable to vaccines increased significantly compared to 2011. Moreover, the proportions of parents concerned about the side effects of vaccines and of parents believing that alternative practices can replace vaccines decreased steadily from 2011 to 2015.

TABLE 5: Percentage of agreement (95% confidence intervals) with selected statements about vaccines

STATEMENT	2011	2013	2015
In general, childhood vaccines are safe	–	–	–
Strongly agree/somewhat agree	94.5 (93.1–95.7)	94.8 (94.3–95.2)	96.6 (95.6–97.5)*‡
Somewhat disagree/strongly disagree	5.5 (4.3–6.9)	5.2 (4.8–5.7)	3.4 (2.5–4.4)
In general, childhood vaccines are effective	–	–	–
Strongly agree/somewhat agree	97.3 (96.3–98.0)	97.1 (96.8–97.5)	98.0 (97.1–98.6)*
Somewhat disagree/strongly disagree	2.7 (2.0–3.7)	2.9 (2.5–3.2)	2.0 (1.4–2.9)
In general childhood vaccines are important to my child's health	–	–	–
Strongly agree/somewhat agree	97.2 (96.2–97.9)	96.6 (96.2–96.9)	97.6 (96.7–98.3)*
Somewhat disagree/strongly disagree	2.8 (2.1–3.8)	3.4 (3.1–3.8)	2.4 (1.7–3.3)
In general, I understand how vaccines work	–	–	–
Strongly agree/somewhat agree	95.7 (94.5–96.6)	96.0 (95.5–96.4)	97.2 (96.3–97.9)*‡
Somewhat disagree/strongly disagree	4.3 (3.4–5.5)	4.0 (3.6–4.5)	2.8 (2.1–3.7)
In general, I am concerned about the potential side effects from vaccines	–	–	–
Strongly agree/somewhat agree	73.9 (71.5–76.2)	69.8 (68.8–70.7)‡	65.9 (63.5–68.3)*‡
Somewhat disagree/strongly disagree	26.1 (23.8–28.5)	30.2 (29.3–31.2)	34.1 (31.7–36.5)
In general, a vaccine can give you a serious case of the very same disease it was meant to prevent	–	–	–
Strongly agree/somewhat agree	40.4 (37.8–43.1)	40.5 (39.4–41.5)	37.6 (35.0–40.2)*
Somewhat disagree/strongly disagree	59.6 (56.9–62.2)	59.5 (58.5–60.6)	62.4 (59.8–65.0)
In general, the use of alternative practices, such as homeopathy or chiropractics, can eliminate the need for vaccination	–	–	–
Strongly agree/somewhat agree	20.0 (17.8–22.3)	18.8 (18.0–19.7)	15.1 (13.4–17.1)*‡
Somewhat disagree/strongly disagree	80.0 (77.7–82.2)	81.2 (80.3–82.0)	84.9 (82.9–86.6)

* Significantly different from the estimate for 2013, $p < 0.05$

‡ Significantly different from the estimate for 2011, $p < 0.05$

STRENGTHS AND LIMITATIONS OF cNICS

The cNICS has several strengths and limitations that must be taken in consideration when interpreting survey results.

STRENGTHS

- Children are sampled randomly from a national roster that includes 96% of children across Canada, yielding a sample representative of Canadian children.
- The cNICS has a good response rate compared to other similar surveys. At 50%, it is higher than the 11% response rate achieved by the adult National Immunization Coverage Survey (6) and the 20% achieved by the Influenza Immunization Coverage Survey (7). It is also higher than the 35% response rates of the United States Centers for Disease Control and Prevention's National Immunization Survey (NIS) conducted in children aged 19–35 months (8) and the 33% response rate of the NIS-Teens in adolescents aged 13–17 years (9).
- This national survey ensures that data is collected in a consistent manner across the Country, irrespective of the difference in immunization schedules, program delivery and tracking systems used by provinces and territories.
- The use of a comprehensive survey including KAB allows the collection of all data required to meet reporting requirements and to inform vaccination programs.
- Since cNICS 2011, 2013 and 2015 were conducted using the same methodology, estimates from these surveys are directly comparable.

LIMITATIONS

- Because interviews were conducted in English or in French, parents not fluent in either official language could not be interviewed, thus excluding their children from the survey. These children may be different from other Canadian children with respect to access to, or utilisation of health services.
- In cNICS, data was collected from parent-held immunization records, in which some information may be incomplete, erroneous or missing. Missing information in parent-held records is more frequent for vaccines delivered in schools such as Tdap, HPV and hepatitis B. In most instances, a child who does not bring his/her record to school on vaccination day will be vaccinated, but the dose received will not be recorded directly in the card or booklet.
- Interviewers used scripts developed for vaccination cards in which antigens (not vaccines) are recorded in chronological order.[I] There was a potential for recording errors when reading through vaccination cards or booklets organized by vaccines.[II]

[I] Newfoundland and Labrador, New Brunswick, Ontario, Yukon, and Northwest Territories

[II] Prince Edward Island, Nova Scotia, Quebec, Manitoba, Saskatchewan, Alberta, British Columbia, and Nunavut

- The measles, mumps, rubella and varicella (MMRV) vaccine was missing from the list of vaccines available to interviewers in cNICS 2011, 2013 and 2015. Therefore, in provinces where MMRV was used, some doses of this vaccine may have been erroneously recorded as MMR, leading to under-reporting of varicella vaccination and underestimation of varicella vaccine coverage.
- In 2011, 2013 and 2015, KAB was not asked of parents of children who had never received any vaccines. The exclusion of children whose parents may be the most adverse to vaccine may have biased the KAB results by over-estimating the frequency of opinions favourable to vaccines in general. This problem will be corrected in cNICS 2017.
- Finally, the 2015 sample size did not allow the analysis of determinants of un- and undervaccination. However, such analysis has been performed using data from cNICS 2013 (10), which had a larger sample size, and the associations found are unlikely to have changed substantially in a two-year period.
- Like many Statistics Canada surveys, cNICS excluded First Nations on reserve communities.

CONCLUSION

All vaccine coverage estimates reported from cNICS 2015 were below the corresponding national vaccination coverage goals. There is therefore a need to improve vaccine coverage in Canada, and one way to go about it is to address the perception or beliefs that reduce vaccine uptake. cNICS findings indicate that although an overwhelming majority of Canadian parents agree that in general, vaccines are safe, surprisingly large proportions of them are concerned about side effects or believe they may get sick from vaccination. It is important that information on vaccine safety in general but also information on how the safety of vaccines is carefully monitored, starting early in the product development and continuing for as long as the vaccine is being used be widely available to parents. These findings highlight the need to enhance the understanding around vaccine hesitancy. The KAB section of cNICS 2017 will be significantly expanded to include measures of vaccine hesitancy based on the Strategic Advisory Group of Experts (SAGE) report on vaccine hesitancy (11).

The analysis of cNICS 2013 data revealed some inequalities in vaccination status that may not necessarily result from vaccine hesitancy, acceptance or refusal of vaccines (10). Therefore, further investigation is needed to gain a better understanding of the socio-demographic factors associated with vaccination status (e.g., socioeconomic status, area of residence) as well as systemic barriers to vaccination. cNICS 2017 will collect additional data elements to explore factors and barriers that influence vaccination coverage in Canada.

The known methodological limitations of cNICS are likely to have biased estimates downward, leading to underestimation of coverage. It is therefore likely that vaccine coverage in Canada is higher than what is shown in this report for all age groups. There is room for improvement in our coverage methods. Indeed, corrective actions have been identified and will be implemented in cNICS 2017.

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APPENDIX

Comparison of coverage estimates from cNICS 2011, 2013 and 2015

	2-YEAR-OLD CHILDREN			7-YEAR-OLD CHILDREN		
	2011	2013	2015	2011	2013	2015
Diphtheria	70.9	76.6‡	76.9	67.9	71.4	74.6
Pertussis	69.7	76.4‡	77.0‡	67.8	70.8	74.9
Tetanus	70.1	76.4‡	76.7	67.7	71.0	74.6
Polio	88.6	90.9	91.2	87.0	89.5	90.2
Hib	64.7	71.9‡	71.9	74.6	80.7‡	77.3
Measles	89.2	89.7	89.2	79.5	85.7‡	85.8‡
Mumps	88.8	89.4	88.9	79.2	85.1‡	86.2‡
Rubella	88.8	89.4	88.9	92.5	94.8	93.5
Meningococcal	84.6	88.7	87.8			

We did not compare Hepatitis B and pneumococcal vaccine data because of changes over time in provincial/territorial programs

We did not compare HPV coverage estimates because of changes over time in the age group at which it was measured (10–14 years in 2011, 12–14 years in 2013 and 13–14 years in 2015).

Varicella data are not show because of data quality concerns (see limitations section)

‡ Significantly different from 2011 ($p < 0.05$).